COLLUSION IN THE INDIAN TEA INDUSTRY IN THE GREAT DEPRESSION: AN ANALYSIS OF PANEL DATA [1]

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Abstract

This paper analyzes the effectiveness of the control schemes in the Indian tea industry during the Great Depression, whereby producers attempted to collude by reducing output. Analysis of data from a panel of plantations shows that collusion was effective. We suggest that the system of management of plantations by "managing agents" enhanced the degree of monopoly in the industry, thereby facilitating collusion. The social cohesiveness of expatriate business may have also contributed to the enforcement of collusion.

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1. INTRODUCTION

The phenomenon of overproduction widely affected agricultural commodities in the interwar period. Price support schemes through restriction of output or export were tried out in many commodities. Since most primary commodities have low price elasticities of demand, output restriction increases the revenues and profits of the producers, and is undoubtedly in their collective interest. Nevertheless, each individual producer has a strong incentive to expand output in response to higher prices, and thus such schemes for restricting output become difficult to enforce. Enforcement of collusion can be a problem at two levels: first, producers from another country can enter the market and second, producers within a country can deviate from the agreement. Enforcement problems are particularly severe in markets with a large number of producers, which are close to the competitive paradigm. This is the case in most agricultural markets, and in these markets, higher prices create incentives for producers to expand output.

This paper examines the schemes which aimed to restrict output in the Indian tea industry during the Depression. Our focus in on the so-called control schemes of the years 1930 and 1933. These schemes are of particular interest since there was an explicit, voluntary agreement by the producers to restrict output. Both the explicitness and the voluntary nature of this agreement is noteworthy. Since the agreement to reduce output was voluntary and not legally enforceable, the agreement must have been enforced non-cooperatively. Further,

the explicitness of the agreement and of the debates regarding its continuance is a major advantage for two reasons. First, it allows us to separate the years in which producers attempted collusion from the years that they did not. Second, the reasons for the continuance/suspension of collusion can also be discerned from this debate. This explicitness is a major advantage of a historical studies of collusion (see also the work of Porter, 1983), since anti-trust legislation no longer permits explicit collusion in most countries.

In order to analyze the effectiveness of collusion, this paper analyzes the output decisions of the plantations at the micro level. We rely upon a panel data set of output, prices and acreage for a sample of 114 tea plantations in Eastern India, the main tea producing region in the country. Our main finding is that plantations reduced output in the years of operation of the control scheme. The extent of this output reduction is significant, in terms of size, as well as statistically. The apparent success of the scheme appears paradoxical given the large number of tea plantations in the industry and the relatively high short run supply elasticity of tea.

We offer two complementary explanations for our surprising finding. First, we suggest that the organizational structure of the industry was one major factor which facilitated "cooperation" or collusion between plantations in output reduction. Plantations were managed mainly by a small number of "managing agents", and this ensured a higher degree of monopoly in the industry, in terms of the effective control structure. The 114 firms were mainly managed by thirteen

managing agents, but five of these managing agents controlled 62 firms. Since each managing agent was responsible for a number of plantations, we suggest that each managing agent did not seek to maximize the profits of each plantation taken separately, but tried to optimize the performance of the set of plantations under their control, as a whole. We suggest that the industry effectively functioned as a "repeated oligopoly", so that collusion was sustained despite producers having the incentive to free ride in the short run.

In addition to the above "economic" explanation for the success of the control scheme, we would also like to suggest that there were socio-political reasons for differential behaviour of different producers. The number of managing agents, while small in relation to the number of plantations, is still relatively large. The managing agents belonged to a small and cohesive social group, of British nationals in a colonial environment. As a cohesive group, they might have been able to impose social sanctions on any member who violated the social norm, and this may have helped to sustain collusive behaviour in the economic domain. In contrast, the smaller and newer producers of the peripheral regions were mainly Indian. Being peripheral to the main social group, they were immune to its sanctions.

The organization of this paper is as follows. Section 2 describes the main features of the market for tea. Section 3 outlines the structure of ownership and control in the Indian tea industry. Section 4 describes the control schemes. Section 5 sets out a simple model of noncooperative collusion. Section

6 presents our econometric model and estimations. Section 7 discusses possible explanations for our results.

2. DETERMINANTS OF DEMAND AND SUPPLY

Britain was the main consumer of tea. Over 50 percent of total world exports of tea was absorbed by Britain. It was the demand and supply in this market that determined international tea prices. India, Ceylon and Indonesia controlled over 80 per cent of the world tea exports. India, the country of our focus, was a major producing country and over 85 percent of India's tea exports was to the United Kingdom. Table 1 shows the overwhelming importance of the British market. Table 2 shows the market shares of the main exporting countries for selected years in the period 1927-1938.

Trends in tea prices are influenced by some special features of the demand and supply of this consumption good. On the demand side, tea occupies a small proportion in the consumers' budget. Up to a certain level of demand for tea is sensitive to changes in price and income. Thereafter, the product shows low price and income elasticities of demand. Superimposed on this there may be a tendency to shift from common to better quality teas as income increases. However, consumer preferences for beverages are somewhat fixed and switching from one beverage to the other may take place over a long period. Therefore the market for tea in the industrialized countries tends to increase in line with population growth. In developing countries, where income levels are lower, demand shows larger price and income elasticities. Estimates

show price elasticity of demand in the United Kingdom to be -0.32 for the period 1920-38 and income elasticity to be 0.04 (Stone, 1954). Calculations of income elasticities for India based on cross section data for a later period, show the income elasticities in the urban and rural areas to be 1.11 and 1.047 respectively (Ayengar, 1967). However, not much effort was made to exploit the domestic market until the 1930s.

In the 1930s the UK market remained stagnant as did other export markets. It was the domestic market in India which showed a dramatic increase. A market which had expanded by only 15 million pounds to 50 million lbs in the decade of the 1920s, showed an increase of 13 million pounds for 1933-34 and consumed over 100 million lbs of tea by the end of the 1930s (Indian tea statistics). India, in the 1930s, had become the second most important outlet for black teas although the per capita consumption was still very low.(Wickizer,1940). This was prompted in part by an aggresive advertising campaign. The ECONOMIST reported in 1931 that when the Indian Tea Cess Committee was spending 50,000 pound sterling annually in advertising in America with apparently little to show for it, considerable success could be seen from an advertising campaign of 45,000 pound sterling in India in the early 1930s. (Economist, October 31, 1931)

On the supply side, supply expansion takes place in the long run mainly through the expansion in acreage. Since tea crops mature in 6-7 years, there is a substantial gestation lag in the adjustment of supply to demand. Nevertheless, there

is also the scope for varying output in the short run, by variations in plucking tea leaves. Finer plucking reduce output, while coarser plucking can increase output. This ability to vary output in the short run is an important feature of tea production, which distinguishes it from other plantation crops. When prices reach rock bottom, output can be restricted by resorting to finer plucking. High prices, on the other hand encourage coarser plucking. This relatively high short-run price elasticity implies that producers can react more quickly to situations of overproduction and excesses in stocks. It is through this instrument that the efforts at price control have sought to operate. Plucking is done manually. Fine plucking refers to careful selection of the finest leaves, while coarse plucking is less discriminating. Therefore plucking not only affects the quantity of output, but also its quality. Coarser plucking implies an increase in the supply of common teas and therefore a lower average quality. Similarly, finer plucking reduces the supply of common teas, thereby raising average quality and prices.

3. THE INDIAN TEA INDUSTRY

The Indian tea industry was set up in the second half of the 19th century. The industry was organized as joint stock companies owning different plantations. An important feature of the pattern of control in the industry was the managing agency system - a few managing agents controlled a large number of tea plantations.

The managing agency in India was the archetype of expatriate British business. A managing agency was usually a partnership, sometimes a privately owned joint stock company which acquired a controlling interest in different industrial enterprises by operating in the share market. The companies were often floated by the managing agents. Each managing agency was involved in different economic activities and in the three major industries in eastern India, tea, jute and coal control rested with the managing agents. Tea was a classic example of control by managing agents. Tea companies in the 1920s and 1930s were registered either as sterling companies in London or as rupee companies in India. Sterling companies accounted for 63 percent of the area under tea in 1939 and Public limited rupee companies for about 32 percent (Plantation Enquiry Commission Report, 1956). However the distinction between sterling and rupee companies was rather thin. Even in the case of Sterling companies, the managing agents exercised control rather than British shareholders(Tomlinson, 1993). The categorization into rupee and sterling companies depended on the place of registration of the company: Calcutta or London and the controlling interests were held by the managing agent.

Bagchi argues-

"whether a company was registered in the U.K.or in India depended primarily on the convenience of the managing agents and a sterling registration did not necessarily mean that much of the capital invested in the plantation was earned outside India. Plantations were generally first opened up by a firm doing business in India or by a planter, who would then turn to a managing agency house for working capital and for additional fixed capital. A planter might, also, open up a plantation and sell it to a joint stock company or a managing agency house for profit. The registration of the company was a

mere formality, since most of the capital was held by the planters of the managing agency firm and their close associates."

In eastern India most of the tea companies were controlled by relatively few managing agents and the place of registration of the company did not cause any significant difference in their functioning. Thirteen leading agency houses controlled 75 percent of the tea output in India. Many managing agents controlled both rupee and sterling companies. A list of sterling companies in 1914 shows that of the 124 companies that existed 42 were controlled by four of the prominent managing agents in the industry: George Williamson and Company, Octavious Steel and Company, Walter Duncan and Company and R.G. Shaw and Company. Their counterparts in India controlled 34 of the 88 tea companies registered in eastern India in 1911 (Bagchi, 1972).

An important implication of the managing agency system was that it may have permitted a higher degree of monopoly in the industry than is indicated by the number of firms in the industry. Although the industry had a very large number of plantations, each of which had a small share in total output, the share of each managing agent in total output was substantially larger. If the firms belonging to a single managing agent acted in concert, and sought to maximize the profits of the group as a whole, this implies that the industry is better viewed as an oligopoly than as a competitive industry. As we have already noted, most firms in Eastern India were controlled by a few managing agents. More than half the firms in our data set are controlled by 5 managing agents and these account

for over 50 percent of the output. Four of these agents are Williamson and Magor with 17 firms, Octavious Steel with 6 Duncan Brothers with 17 and Shaw Wallace with 5. These managing agents were important for both sterling and rupee companies. The fifth Andrew Yule controlled 12. A single managing agent being responsible for the performance of a number of plantations was more concerned with the performance of these plantations taken together, rather than any single plantation. Consequently, these managing agents would partly internalize the negative externality which expanding output conferred upon the industry as a whole.

The industry came to be organized into associations to represent the interest of the producers as early as the 1880s. Indian Tea Association was founded in 1881 with representatives of nine managing agency houses which had major interests in tea. The setting up of district-level organizations followed. The Indian Tea Association was the dominant player in north India. There were several small associations representing Indian interests. They worked in harmony with the Indian Tea Association and usually emphasized their specific problems arising due to size (Griffiths, 1967). Southern planters had their own association known as the United Planters' Association. Right from the beginning there was a difference between the two associations- while individuals dominated the functioning of the United Planters' Association and dissent was common, in the Indian Tea Association big companies exercised tight control (Griffiths, 1967).

4. CONTROL SCHEMES

The attempts to restrict output in the 1930s were prompted by the decline in tea prices after 1925. Prices fell, both in Calcutta and in London, in the period 1925-29, and this decline was also accompanied by an accumulation of stocks - in 1929, the stocks in London represented six months' supply, the highest in 30 years. The first control scheme was devised at this point, and took effect in the year 1930. This scheme was backed by an international agreement, between the associations of tea producers of India, Ceylon and Indonesia. The agreement was that tea plantations would reduce output, and that the extent of output reduction would be greater for lower quality common teas. There was a gradation of four qualities, and the implicit quotas (which had no legal sanction) were fixed as a proportion of 1929 output. These proportions ranged from 85 percent, for the lowest quality producers, to 97 percent, to producers of premium tea.

From our perspective, the important aspect of the first control scheme is that compliance with the scheme was purely voluntary - there was no legislative action which enforced output reduction or regulated exports. Nevertheless, the aggregate data on tea production suggests that the scheme was successful in India, where output declined by 10 percent (International Tea Statistics). However, there were disagreements regarding continuation of the agreement. The main problem was that Indonesia was not perceived to be doing enough - the reduction in Indonesian output was only 5 percent and further, producers in Indonesia were unhappy with the terms

of the agreement. There were also divergent opinions within India - although the major tea producers of Eastern India would have liked an extension of the control scheme, the United Planters's Association representing producers in South India were divided in its opinion. The Chairman of the association spoke strongly against restrictions on output citing the failure of such schemes in coffee and rubber (Griffiths, 1967). As a result, despite a dismal price situation, the control scheme was given up after one year, and there was no agreement to reduce output in the years 1931 and 1932. Prices reached a rock bottom in 1932 in all categories of tea, and the low prices of good quality teas prompted consumers to switch away from common teas, resulting in a large increase in the stocks of common teas.

This fall in prices prompted the International Tea Agreement of 1933, between the main producer nations, India, Ceylon and Indonesia, who accounted for 80 per cent of the world tea output. The agreement envisioned a reduction in output as well as exports, and required the governments of the respective countries to legislate in order to ensure compliance with the agreement.

In India, legislation pertained to exports and to the expansion of acreage, and took effect in November 1933. The Indian government passed the Tea Control Act to regulate exports of tea and planting. Export quotas were fixed for the next five years on the basis of maximum annual export in the period 1929-31. The expansion in acreage was to be limited to 0.5 per cent of the existing planted area.

To summarize, the control scheme of the years 1934-38 had the backing of the Indian state, which legislated export quotas and restricted expansion of acreage. Although there was no direct legislation to restrict output, it is clear that the combination of export/acreage restrictions could provide a close substitute. The international market was pre-eminent, and from international trade theory, it is clear that export restrictions will translate into reduced output (see for example, Corden, 1984). The control scheme was successful in reducing exports and output, thereby raising tea prices. In 1933 aggregate output in India declined by 12 percent and in Ceylon and Indonesia by over 10 percent (International Tea statistics). The average price of tea in the Calcutta auctions rose by 80 percent.

The year 1933 provides an extremely interesting year of transition. In January 1933, a referendum was held within the India tea industry, and showed 92 per cent of the producers in support of the scheme, with a mere 2.5 per cent dissenting and the rest were undecided (Griffiths, 1967). The international tea agreement was signed in February. The Tea Licensing Committee was set up in June to allocate export quotas. and the Tea Control Act, which gave legal sanction to these quotas, was passed by the Government of India in November. In the interim, in a second referendum in June, over 90 percent of the Indian tea industry expressed support for voluntary output restriction. This sequence of events illustrates three important points. First, there was a more-or-less explicit agreement for voluntary output reduction in the industry, for

almost the entire year. Second, the export restrictions were not given legislative sanction for most of the year. Third, producers in the industry were aware, from at least March, if not earlier, that legislative action was forthcoming to reduce exports, and that such action would be in force fairly soon.

The focus of this paper is on the producers' compliance with the control schemes in the years 1930 and 1933. In the year 1930, any compliance must have been entirely voluntary, since there was no legal enforcement of the control scheme. The year 1933 is more complex. As discussed in the previous section, there were no legal measures to restrict output, and the enforcement of export quotas only came at the end of the year. Further, since producers were aware that legally binding export quotas would be in force in the future, these anticipations could affect there current behaviour.

The tea producers of eastern India also made efforts to secure legislative control on output for the domestic market. In June 1933, a referendum within the industry on a scheme to limit production for sale in India to 12 per cent of each estate's best crop showed a mixed response - the sterling companies in both east and south supported the scheme, but the southern rupee companies were divided. The scheme was not given legislative effect due to opposition from the United Planter's Association representing the southern estates. Tea production declined from 434 million pounds in 1932 to 383 million pounds in 1934. Voluntary restriction continued in 1934, 1935, 1936 and 1937, although the support for restricting output was obtained with some difficulty in 1936. As the

price situation improved the proportion of output that could be produced for the Indian market was raised to 14 percent.

The success of the price support schemes in the tea industry may be attributed to the ability to reduce output. Regulating output through plucking was undoubtedly important for this. The question which is addressed in this paper is how did the effect of the control schemes translate to the level of the individual firm. Was the restriction on output enforced at the level of the firm? Although the circumstances of the control schemes were different, if firms reduced output voluntarily in 1930 and 1933, then there was explicit collusion in the industry in order to raise international prices.

5. A SIMPLE MODEL OF NON-COOPERATIVE COLLUSION

Consider an oligopolistic industry with n firms, {1,2,...,n}. We make two simplifying assumptions - first, the product is homogeneous, and second that all firms have identical cost functions. Let q_i be the quantity produced by firm i and let the total output of the industry be denoted by:

$$Q = \sum_{i=1}^{n} q_i \quad \text{.....(1)}$$

The industry price is given by the inverse demand function p(Q). The firm's profits are given by:

$$\pi = q_i p(Q) - c_i(q_i) \quad \text{.....(2)}$$

Let Q_{-i} denote the total output of all firms except firm i, that is $Q_{-i} = Q - q_i$.

Equation (2) reveals that the firm's profits depend on its own

output (q_i) and the aggregate output of the other firms (Q_{-i}). Write $\pi(q_i,Q_{-i})$ for this function.

Our focus is on symmetric equilibria. Suppose that all firms in the industry are producing q units of output. Define the best response of firm i, $\phi(q)$, by:

$$\phi(q) = \underset{q_i}{\text{argmax}}\ \pi[q_i,(n-1)q] \quad \text{.....(3)}$$

We assume that $\phi(q)$ is continuous and decreasing. A Cournot Nash equilibrium is a fixed point of this function, i.e. a (q*) such that $q^* = \phi(q^*)$. Under our assumptions, a Cournot Nash equilibrium exists and is unique.

Since the work of Friedman (1971), it is well known that repeated interaction allows firms to collude. Suppose that the oligopoly is infinitely repeated and that firms maximize discounted profits, where δ is the discount rate. Firms can restrict output to the level q^c. This collusion can be supported in the following way: if all firms collude in period t and produce q^c or less, the collusion continues in subsequent periods, so that firms continue to restrict output to q^c. However, if any firm deviates in the current period, then all firms switch to producing the Cournot output q* for T periods. Such a strategy is called a T-period trigger strategy. In the extreme case, of an infinite trigger, the reversion to Cournot behaviour is for the entire future. Such a trigger strategy allows firms to collude, since a deviation from collusive behaviour is made unprofitable. Although each firm can increase its profits in the current period by increasing output, it

suffers the loss that future collusion breaks down. An output level q^c can be supported in this way, by an infinite trigger strategy, if:

$$\pi(\phi(q^c),(n-1)q^c) - \pi(q^c,(n-1)q^c)$$
$$\leq [\delta/(1-\delta)]\ [\pi(q^c,(n-1)q^c) - \pi(q^*,(n-1)q^*)] \quad \ldots\ldots\ldots\ldots (4)$$

Let q^m be the maximum level of collusion that can be sustained in this industry.

Although the above shows that collusion can be a non-cooperative equilibrium in repeated interaction, this is not the only equilibrium . Producing Cournot outputs in every period continues to be an equilibrium. In fact, every output level between q^m and q^c can be supported as an equilibrium in the industry. This suggests that coordinating on a single equilibrium is perhaps a more difficult problem than enforcing the equilibrium. This coordination problem is aggravated when producers are heterogeneous since there is not even a unique symmetric equilibrium which is most collusive. The control schemes may have played an important role in overcoming the coordination problem, so that all producers agreed to shift from a less collusive equilibrium, in the period before 1930, to a more collusive equilibrium, in the years of the control schemes. In this interpretation, the control schemes, being voluntary, did not change the industry fundamentals and the set of possible equilibria, but coordinated expectations in the move from a less collusive to a more collusive equilibrium within this set.

We now augment this simple model, to examine the effect of quotas, i.e. legally enforceable output restrictions.

First, quite obviously, quotas may allow a greater degree of output restriction than is feasible non-cooperatively. More subtle is the effect of an expected introduction of quotas in the future, which is relevant for our analysis of the year 1933. Suppose that firms expect quota levels q^k to be enforced from the next period, where $q^k < q^*$. This implies that Cournot behaviour is no longer possible in the future. This makes collusion more difficult this period, since the quotas reduce the severity of future punishments. Current outputs (q_i) are supportable as an equilibrium if:

$$\pi(\phi(q^c),(n-1)q^c) - \pi(q^c,(n-1)q^c)$$
$$\leq [\delta/1-\delta]\ [\pi(q^c,(n-1)q^c) - \pi(q^k, (n-1)q^k)].....(5)$$

Since $q^k < q^*$, the right hand side of equation (5) is less than the right hand side of equation (4) and hence less collusion is possible in the current period. Further, consider the case where $q^k < q^m$, i.e. the quota seeks to enforce the an output reduction which is at least as low as that the industry can enforce non-cooperatively. In this case future punishment is completely ineffectual, and there can be no collusion today, i.e. the only equilibrium is where the industry chooses the Cournot output today. Hence we may conclude that the expectation of quotas in the future makes collusion more difficult today (see Rotemberg and Saloner, 1986, Shapiro, 1989).

The literature since Friedman has augmented this simple model of oligopolistic collusion in several ways. Abreu (1986) showed that firms could sustain a higher degree by taking recourse to punishments which were more severe than Cournot

reversion. Green and Porter (1984) and Porter (1983) analyze the situation where firms could not monitor the output decisions of their rivals, and showed that collusion could nevertheless be supported.

These models of oligopolistic collusion consider the situation where all firms in the industry are partners to the collusive agreement, and where there is no new entry into the industry. This is not quite the case in the tea industry, where barriers to entry were not so significant. The industry had a "competitive fringe" of independent tea planters, who were not controlled by managing agents. These plantations were mainly located in South India, were smaller in size then the plantations of Eastern India, and were mainly Indian owned. Oligopoly theory suggests that these smaller firms would have less incentive to stick to a collusive agreement, since their marginal revenue from expanding output is large, due to their small effect on the market price. Legally enforceable quotas may therefore be more important in order to restrain such firms from expanding market share during the period of a collusive agreement. The existence of a competitive fringe is likely to have prompted the Indian Tea Association to lobby for legislative control rather than have an informal collusive arrangement within the industry.

6. EMPIRICAL RESULTS

We analyze two different types of data in this section of the paper - aggregate time series data and firm level panel data. Our purpose is to estimate the effect of control schemes

on output. We begin by analyzing annual time series data on the quantity of aggregate output of tea and a price index of tea, over a period of 21 years, from 1919 to 1939. We estimate an aggregate supply-response function in the industry, based on the following equation:

$$\ln y_t = \beta_0 + \beta_1 \ln p^e_t + \beta_2 \text{ time} + \beta_3 cs_t + \varepsilon_t \quad \ldots\ldots\ldots (6)$$

where $\ln y_t$ is the aggregate output of tea in India in logs, $\ln p^e_t$ is the logarithm of the expected price of tea, time is a time trend representing shift factors, and cs_t is a dummy variable which takes the value one in the years when control schemes are in operation. These are the years when output or exports are regulated, either by voluntary agreement or by law, i.e. the years 1920, 1930, 1933, and 1934-39. We use two methods for proxying the expected price. The first is the lagged price of tea, which is valid as a regressor for the expected price if producers have adaptive expectations. The second approach is to assume that the producers have rational expectations. In this case the expected price equals the actual current price plus a white noise error term. In this case, we include the current price amongst our regressors, and use instrumental variables for estimation.

The results are reported in table 3. Two factors need to be noted. First, the elasticity of supply of tea is significantly different from zero in either estimation, and is around 15 percent. Secondly and more importantly from the point of view of this paper, the control schemes seem to have no signi-

ficant effect on output. Although the coefficient on the control scheme dummy is negative, it fails to be statistically significant. This negative result seems robust across a number of different specifications that we estimated, and is noteworthy, since the many of the years witnessed explicit legal restrictions upon exports. We also experimented with a number of other specifications, including for example lagged output as a regressor, in order to allow for possible sluggish adjustment. These other regressors failed to be significant, and did not modify our basic results. This result may be contrasted with the results we obtain using firm level data, which we now turn to. In our view, the firm-level data is more informative since it provides information at the level of the micro-unit.

The focus of this paper is on firm level data, which includes annual output figures on a sample of 114 firms for a period of five years, 1929-1933. These firms are rupee companies, which are all managed by managing agents, and are located in four regions of eastern India: Assam, Cachar and Sylhet, Darjeeling, Dooars and Terai. The tea produced by these companies are of different qualities, depending on the region, ranging from the fine teas of Darjeeling to the common teas of Cachar and Sylhet. The prices of the various qualities of tea reflect the differences in quality, and we have region-specific prices for each of the years under consideration. These prices are those quoted in the Calcutta auctions for teas of each of the four regions.

We estimate the effect of control schemes on the output

decisions of these companies. In the five years under consideration, control schemes are operative in 1930 and 1933.
We do not include the other years of export regulation since the reduction in output could be due to the existence of quotas and tight control exercised by the Licensing authority.

Our hypothesis is that the output of firm i, belonging to region j, in year t is given by the following supply function:

$$x_{it} = \alpha_i + \beta_1 p_{jt} + \beta_2 cs_{30} + \beta_3 cs_{33} + \varepsilon_{it} \ldots\ldots\ldots (7)$$

where x_{it} is the output of firm i in year t, and p_{jt} is the price of tea in year t in the relevant region. cs_{30} and cs_{33} are dummy variables which take value 1 in the years 1930 and 1933 respectively. We estimate this basic equation in levels as well as in logs, i.e. taking ln x_{it} and ln p_{jt}. In either formulation we allow for firm specific fixed effects, i.e. we allow α_i to differ across firms. This is a major advantage of our data set, i.e. that we are able to allow for heterogeneity across firms arising from differences in soil quality, past investment levels, managerial input, etc.

A remark is in order regarding the use of p_{jt}, the region specific price, in the regression. We use the price as a proxy for demand shift variables, which we do not observe. The price variable will be exogenous only if the individual firm acts as a price taker. This assumption is of course open to question - our discussion of the managing agency system suggests that even if the individual firm is small, the managers of the firm could well take into account the negative effects of their

output decisions upon other firms in the industry which were managed by the same agency. Accordingly, we estimate the equation by instrumental variables as well as ordinary least squares. We estimate a fixed- effects model using ordinary least squares. Next we assume price to be endogenous. We estimate the equation in first differences using lagged price and lagged output as instruments.

Tables 4 and 5 report our estimations. Table 4 reports the results for the specification in levels while table 5 shows our results for the specification in logs. Both tables report the ordinary least squares regression and the case when the price variable is instrumented. Our basic finding is robust and is replicated in all our regressions. The coefficients on both the control scheme variables is negative and statistically significant. The estimation procedure (OLS versus IV) does not affect the coefficients on the control scheme variables. The effect of the control scheme is larger in magnitude in 1933 than in 1930. This difference is significant- the null hypothesis is that β_2 is equal to β_3 rejected by an F- test. This is not surprising as the circumstances of the two control schemes were different as we have already discussed.

However, when we estimate a more restrictive formulation of equation (7) by using a single dummy variable for the control scheme, thereby restricting the coefficients to be identical, our basic result remains the same- the coefficient of the dummy variable is negative and statistically significant (see table 6).

The other coefficient of interest is the coefficient of the price variable. This is positive in all the formulations and statistically significant when estimated with ordinary least squares.

7. AN EXPLANATION

Our main empirical finding is that the plantations in our sample reduced output significantly in the years of operation of the control schemes, i.e. the years 1930 and 1933, the extent of output reduction being somewhat larger in the latter year. This reduction, we claim was voluntary and the firms' compliance with the control schemes indicates collusive behaviour in the industry. The importance of this finding, based on firm level data, needs to be highlighted, since our analysis of aggregate time series data for a longer period, including a period of legally enforced export quotas, fails to find a significant effect of the control schemes upon output. In this section we discuss possible explanations for the success of the scheme in the years 1930 and 1933.

One explanation for the success of the control schemes is in terms of the model of collusive behaviour. As section 3 of this paper has discussed, the managing agency system permitted the industry to effectively function as an oligopoly. Effective control in the industry was more concentrated than is suggested by the number of firms. This may have allowed the industry to sustain a collusive outcome despite the absence of any legal sanctions which enforce collusion. Despite this potential for collusive behaviour, the industry remained at a

relatively non-collusive equilibrium in the period before 1929. The control scheme of 1930 represented an explicit agreement to move towards a more collusive equilibrium, thus overcoming the coordination problem arising from the multiplicity of repeated game equilibria. This was also the case in 1933.

This raises the question, what did the reversion to more competitive behaviour in the years 1931 and 1932 represent? Was it a punishment phase, in response to the failure of some producers to comply with the 1930 agreement? Or was it simply a reversion to a less collusive equilibrium, due to the absence of an agreement to coordinate expectations. In our view, the first interpretation seems somewhat unlikely, on two counts. First, our empirical results show that firms in 1930 reduced output, in line with the agreement. Second, the firms of Eastern India (of which our sample is a subset) were keen to continue the agreement, as our discussion of section 4 shows. The main opposition to the agreement came from a section of the planters of South India, and seem to be motivated more by their dissatisfaction with the terms of the agreement than the perception that some firms were cheating. Hence it seems more likely that the break-down of collusion in the years 1931 and 1932 were due to failure to renew the agreement of 1930- a problem of coordination. On this interpretation, the two periods, 1930 and 1933, and 1931-32 represent two different equilibria rather than different phases of a single repeated game equilibrium. We note here the great advantage of our data set, which makes it possible to disentangle the

different possible interpretations. The control schemes represent an explicit, non-binding agreement. The explicitness of the agreement, and the open discussions regarding it, allow us to discern the views of the parties concerned in a way which is not possible when collusion is tacit or secret, as is normally the case in contemporary times.

The failure to renew the agreement in 1931-32 was not probably anticipated in the year 1930, when firms decided to comply with the control scheme, since otherwise the firms would have little incentive to comply. Nevertheless, firms must have been aware that there was opposition to the control scheme from some quarters, and consequently that such a non-renewal was possible. This would have undermined the incentive to collude in 1930. Similarly, in the year 1933, firms were well aware that legally enforced quotas were imminent. As we have discussed in section 5, this makes collusion very difficult. Nevertheless, our data shows that firms did reduce output in both years, and in fact the extent of output reduction was greater in the year 1933 than in 1930. This suggests that there were perhaps other factors which helped sustain collusion in this period, over and above the models of collusion which we have discussed. We turn to these other factors now.

The plantations controlled by managing agents in eastern India reduced output, whereas the smaller independent plantations of South India and other peripheral areas expanded market share in this period. Our finding with micro data that firms reduce output in response to the control scheme is in

line with aggregate data on tea output. The latter show that there is a decline in output in the two years when the control scheme is operative- 1930 and 1933 (see table 7). The only dissent appears to be from the producers in Bihar, Uttar Pradesh and Punjab who accounted for less than 1 percent of the tea output. Data show that there is an increase in their output in 1930 and 1933 and total output increased by over 40 percent between 1929 and 1937. There is also a steady increase in the total output of the south Indian plantations- in 1937 their output is 22 percent higher than the output of 1929. For Assam and Bengal the output level in 1937 was still lower than that at the beginning of the Depression. This again points to the existence of a competitive fringe in the industry. They were the free-riders and increased their market share in the period of the collusion.

In addition to the above purely economic explanation, there may also be a socio-political reason for the success of the control scheme, and for the differential response between the plantations in Eastern India and the South. The plantations of Eastern India were mainly British owned, and the managing agents were British expatriates as well. The plantations in the South were mainly owned and controlled by the rising Indian capital, and the 1920s had seen a rapid entry of Indian capital into the industry. British expatriate business in India was a small and cohesive social group, with a keen sense of its own identity in a colonial environment. This social cohesion was all the greater in tea plantations, which were far from any metropolis, and close only to each other. In

a small and isolated social group where any individual has few opportunities for outside interaction, social sanctions are powerful. Akerlof (1976) has argued that such social sanctions may prevent an individual from maximizing his or her individual economic benefit. Consequently, output restriction may have been facilitated, since any deviator would have face social sanctions. Such social sanctions did not apply to the plantations in the peripheral areas. The Indian planters did not belong to the same social group and the same sanctions could be applied to them. Indeed, it has been argued that the control schemes were used to maintain the domination of the British managing agents and prevent the entry of Indian capital (Rothermund, 1992). The active campaign by the Indian Tea Association for legislative controls on exports and output indicates that although firms colluded successfully, they anticipated free-riding and perceived legislation to an effective way to prevent this. The Association even offered help to the customs authorities in monitoring exports (Rothermund, 1992).

The 1920s had seen a rapid increase in the entry of Indian capital in industry. The Tea Agreement, by setting export quotas on the basis of past performance, froze the relative position of firms in the export market. The restriction on acreage prevented entry as well as expansion of new plantations. So the agreement went against the interest of the new plantations. Many of these were located in the south of India. Most of the plantations in the east had been in existence for a longer time and had attained their desired capacity. All the companies in our data set had been in existence in 1920. This

group had an interest in maintaining status-quo. Although the export quotas were fixed, the southern planters had increased their market share from 13.5 percent to 16.6 percent. At the same time, the firms in Assam and Bengal appear to have restricted output voluntarily and lost market share. This is borne out by our econometric estimation. The collusion worked well within one group of planters and not the others. The success of the control schemes in regulating output at the level of plantations in Assam and Bengal may be explained by the close control exercised by the managing agents. However, the social aspect of the group behaviour must also be emphasized.

The majority of the planters in Assam and Bengal belonged to the expatriate business community. This was not true of the south where many of the new plantations belonged to the Indian capital. Many of the planters in the south were new and the plantations were smaller. They had their own association and were not willing to go along with the ITA on many occasions. Collusion was effective within the same social group, but was not effective for "outsiders" to the group. The break down of collusive behaviour in the jute industry may be related to the presence of many firms outside the cartel, mainly representing Indian capital which led to considerable free-riding by firms outside as well as inside the jute mills' association (Goswami 1991, Tomlinson 1993). In the tea industry on the other hand the control of the expatriates dominant in the 1930s and they did collude successfully to increase international prices.

The response of the firms in eastern India may be understood by looking at the colonial context and the operation of expatriate business. Many kinds of economic and non-economic entry barriers were used to maintain a privileged position. Restricting output to maintain prices was an accepted norm among the agents and was used in several industries. The role of social factors in the group behaviour may perhaps explain why firms voluntarily restricted output rather than play truant in an industry where the control of expatriate business was still dominant.

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TABLE 1

CONSUMPTION OF TEA IN MILLION POUNDS

	1930-34	1935-39
U.K.	442.3	443.0
U.S.A.	86.6	87.7
U.S.S.R.	46.7	37.5
India	51.1	88.0

SOURCE: V.D, Wickizer, Coffee, Tea and Cocoa: an economic and political analysis

Table 2

SHARE IN WORLD EXPORTS(PERCENT)

YEAR	INDIA	CEYLON	INDONESIA
1927	40.8	25.0	15.9
1930	40.1	26.1	17.7
1934	38.7	27.0	18.6
1938	36.1	25.6	17.2

SOURCE: International Tea Committee, Bulletin of statistics.

Table 3

REGRESSION RESULTS: A TIME-SERIES ANALYSIS (1919-39)

SHORT-RUN SUPPLY RESPONSE TO PRICE

Dependent Variable: ln output

	OLS	IVE
CONST.	3.9 (16.05)	3.8 (6.3)
TIME	.02 (5.9)***	.02 (4.1)***
LN $PRICE_t$		.16 (1.29)
LN $PRICE_{t-1}$	.145 (2.9)***	
CS	-.04 (.91)	-.04 (.70)
R^2	.78	
OBS	21	21

NOTE: The t-ratio is given in parentheses.

*** denotes significant at 99 percent.

Source: Investors' India Year Books.

TABLE 4

ANALYSIS OF PANEL-DATA

No. of Firms = 114

Dependent Variable: Output

Equations	OLS	IVE
constant	6216.0 (23.1)	
p_t	2.8 (1.0)*	3.26 (0.6)
cs_{30}	-608.6 (3.95)***	-737.75 (4.9)***
cs_{33}	-772.5 (5.03)***	-1204.9 (3.9)***
R^2	.97	
OBS.	570	456

NOTE: The t-ratio is given in parentheses.

* denotes significant at 90 per cent.

** denotes significant at 95 percent.

*** denotes significant at 99 percent.

Source: Investors' India Year Books.

TABLE 5

ANALYSIS OF PANEL-DATA

No. of Firms = 114

Dependent Variable: ln Output

Equations	OLS	IVE
constant	8.14 (51.7)	
ln p_t	.065 (1.8)*	.04 (.84)
cs_{30}	-.07 (3.3)***	-.09 (5.2)***
cs_{33}	-.13 (6.1)***	-.16 (4.4)***
R^2	.96	
OBS.	570	456

NOTE: The t-ratio is given in parentheses.

* denotes significant at 90 per cent.

** denotes significant at 95 percent.

*** denotes significant at 99 percent.

Source: Investors' India Year Books.

TABLE 6

ANALYSIS OF PANEL-DATA

No. of Firms = 114

Dependent variable: ln output

EQUATIONS	OLS	IVE
Constant	8.14 (51.4)	
p_t	.063 (1.8)*	.08 (.56)
cs	-.10 (5.6)***	-.13 (4.7)***
R^2	.96	
OBS.	570	456

NOTE: The dummy variable cs takes the value the value 1 for 1930 and 1933 and 0 for the other years.

The t-ratio is given in parentheses.

* denotes significant at 90 per cent.

** denotes significant at 95 percent.

*** denotes significant at 99 percent.

Source: Investors' India Year Books.

Table 7

CHANGES IN REGIONAL OUTPUT

(1929-1937)

INDEX OF OUTPUT	REGIONS		
	ASSAM & BENGAL	BIHAR,UP& PUNJAB	SOUTH INDIA
1929	100	100	100
1930	89.6	106	94
1931	90	97	97
1932	99	78	107
1933	86	115	104
1934	90	121	104
1935	88	119	110
1936	89	125	111
1937	95	141	122

SOURCE: International Tea Committee, Bulletin of Statistics, 1946.